Space Weather Technical Forecast

Issued on Sunday, 04 September 2022 at 00:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Blackouts). G1/G2 Minor/Moderate Geomagnetic Storm expected day 1 and day 2 (04th & 05th Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low with periods of C-class flares throughout, the largest being a C3 observed at 03/1649 UTC and originating from AR3089. There are four sunspot regions on the visible disc. The largest and most complex remains AR3089, now approaching the southwestern limb. This region continues to grow, with proliferation of spots on its trailing portion, these merging into a large homogeneous penumbra. The re-connection of the positive delta region within the largely negative trailing portion has led to a classification of Eki/Beta-Gamma-Delta. AR3092, AR3093 and AR3094 remain relatively small and simple in comparison, largely inactive with no or limited growth. No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, was indicative of a transition to a high speed stream, most likely from CH19/+. The solar wind speed increased from 400 to 570 km/s around 03/0830 UTC, preceded by a sharp rise in density, with a peak of 32 ppcc around 03/0500 UTC. Then later in the period, the solar wind speed settled to around 480-540 km/s while density came back to average. Total interplanetary magnetic field strength (IMF), Bt, was initially weak but became moderate between 03/0500-1000 UTC reaching 10-12nT, then became weak again. The north-south component, Bz, was initially largely positive but switched and became largely negative after 03/0630 UTC, with a peak of -9nT at 03/0725 UTC. The Phi angle was initially negative (Away from the sun) but became erratic for a time, before settling into a positive orientation after 03/0515 UTC. Geomagnetic activity was Unsettled to Active with one G1/Minor storm period at 03/0000-0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured at GEOS-16 was at background levels. The high energy electron flux (greater than 2 MeV) became moderate but stayed well below high levels. The 24-hour integrated electron fluence remained well below the Active threshold (1e8 integrated pfu) but displayed a slight rising trend, with 6.95e6 integrated pfu observed at 04/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain largely Low, with an ongoing chance of Moderate flares at times, mostly from AR3089. However, a new region may rotate onto the northeast limb on 05 Sept (day 2), potentially increasing the probabilities of significant flares.

Solar Wind / Geomagnetic Activity: The CME that left the sun on 02 Sept may give Earth a glance on day 2 (05th). No other Earth-directed CMEs expected otherwise. Solar winds are expected to be mostly elevated through the period, perhaps strong on day 1, due to the onset of the HSS originating from a large coronal hole. Geomagnetic activity is expected to remain Unsettled to Active from day 1 (04th) to day 3 (06th), then Quiet to Unsettled on day 4 (07th).

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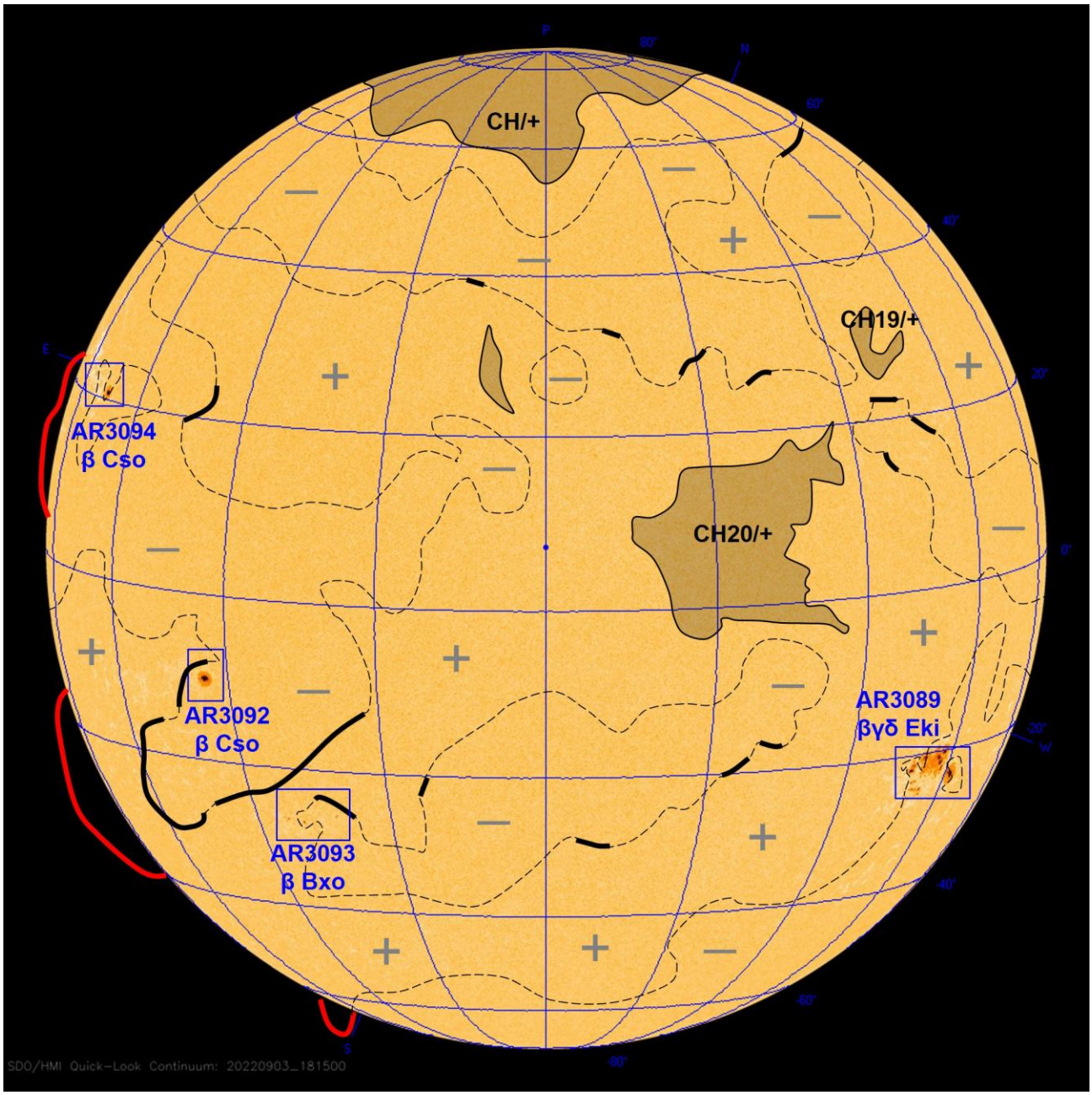
Some G1/G2 Minor/Moderate storm intervals are probable on day 1 (04th), due to the onset of the HSS from CH20/+, and perhaps on day 2 (05th), under coronal hole and CME influences.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels. The high energy (greater than 2 MeV) electron flux is expected to rise erratically and become high over the following days. The corresponding 24 hour fluence is expected to display a sharp rising trend from day 1, with a chance of exceeding the Active threshold on day 3 (06th) and day 4 (07th).

Figure 1. Solar Analysis Valid 03/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A marked filament eruption was observed leaving the sun on 02 Sept. The CME that followed may give a glancing blow at Earth on the 05 Sept (day 2), however confidence is low regarding this. ENLIL suggests only a slight perturbation in the already elevated wind speeds on 05 Sept, this is considered to be good guidance with little overall impact at Earth.

Solar winds are currently slightly elevated, most likely under the influence of the HSS originating from CH19/+. This feature precedes the much larger coronal hole 20/+, expected to become geoeffective during the early hours of day 1 (04th). CH20 is a recurring feature that generated solar wind speeds close to 600 km/s on the last rotation, generating a couple of minor/moderate storm intervals. With the autumn equinox approaching and a coronal hole slightly larger this time round, the connection should be very effective and lead to faster velocities, around 600-650 km/s.

CH20 is running on time when compared to the previous rotation, giving good confidence in the SWPM (Solar Wind Persistence Model). Solar winds are expected to remain strong or elevated through much of the period, only slightly declining. This is also confirmed by ENLIL, seemingly giving good guidance after it managed to capture the arrival of CH19's high speed stream.

All things considered, geomagnetic activity is expected to remain Unsettled to Active from day 1 (04th) to day 3 (06th), then Quiet to Unsettled on day 4 (07th). Some G1/G2 Minor/Moderate storm intervals are probable on day 1 (04th), due to the onset of the HSS from CH20/+, and perhaps on day 2 (05th), under coronal hole and CME influences.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	80	50	5	1
Strong	**G3**	No	10	5	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/0021 UTC	Partial	Filament eruption	SE limb	750	05/1300 UTC +/- 9 hrs	Limited shock expected

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Figure 2: SWPM, considered to provide good guidance

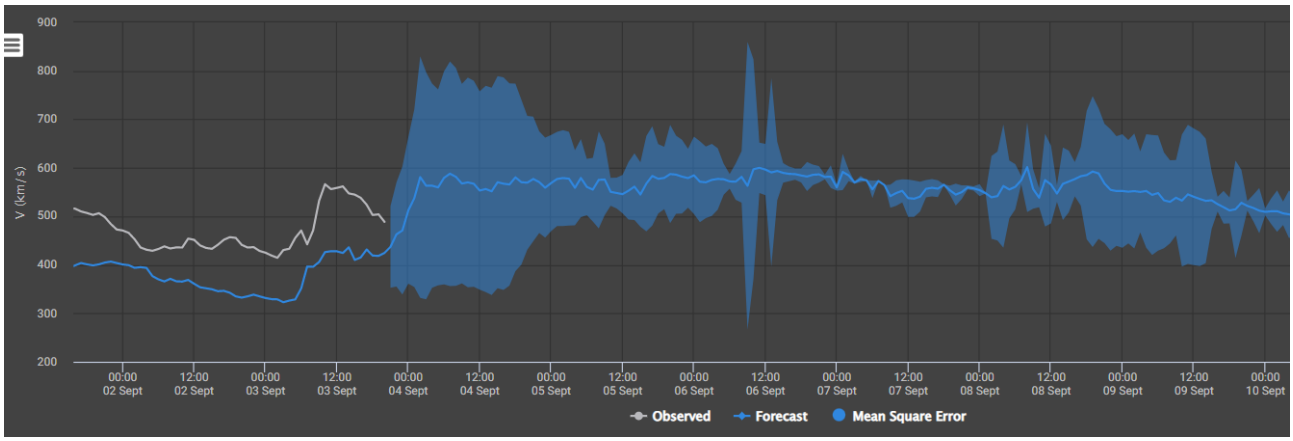
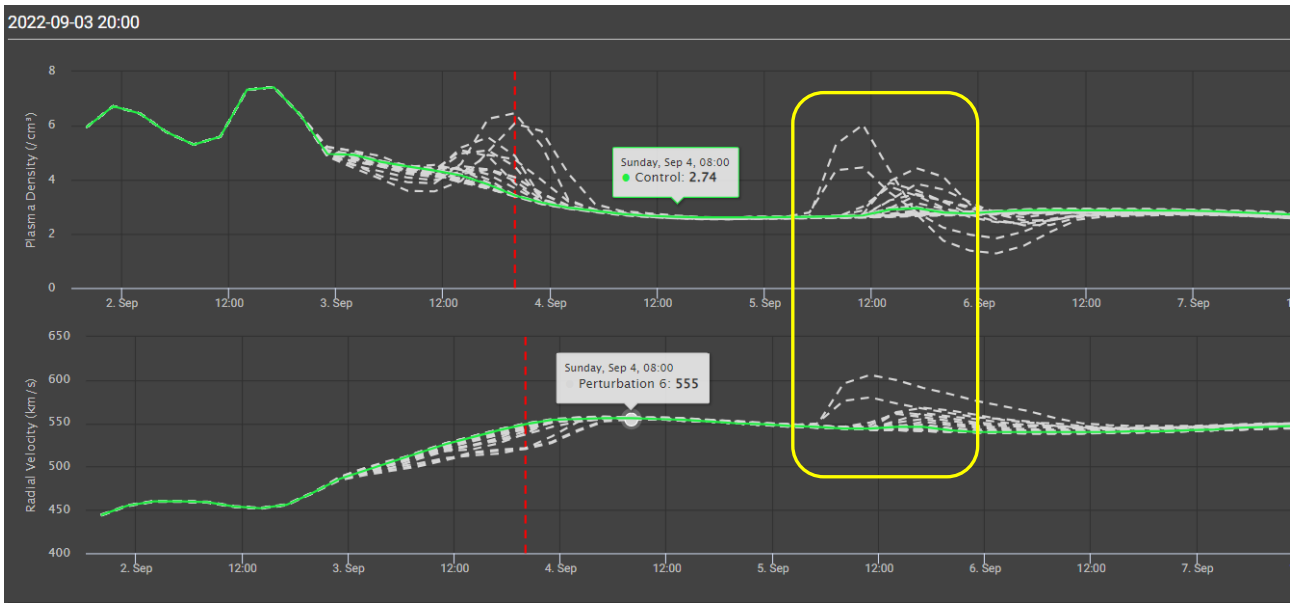


Figure 3: Enlil Ensemble, estimating the arrival of the 03rd Sept CME around 1300 UTC on Monday (yellow area)



Radio Blackouts - X-Ray Flares:

Solar activity was Low with periods of C-class flares throughout, the largest being a C3 observed at 03/1649 UTC and originating from AR3089. There are four sunspot regions on the visible disc. The largest and most complex remains AR3089, now approaching the southwestern limb. This region continues to grow, with proliferation of spots on its trailing portion, these merging into a large homogeneous penumbra. The re-connection of the positive delta region within the largely negative trailing portion has led to a classification of Eki/Beta-Gamma-Delta. AR3092, AR3093 and AR3094 remain relatively small and simple in comparison, largely inactive with no or limited growth.

A large filament is visible in the southeast quadrant and will need to be monitored for any lift-off, particularly when it approaches the central meridian.

Solar activity is expected to remain largely Low, with an ongoing chance Moderate flares at times, mostly from AR3089. However the farside solar map from Raben Systems, Inc indicates the presence of an active region approaching the northwest limb. It is currently not visible on the

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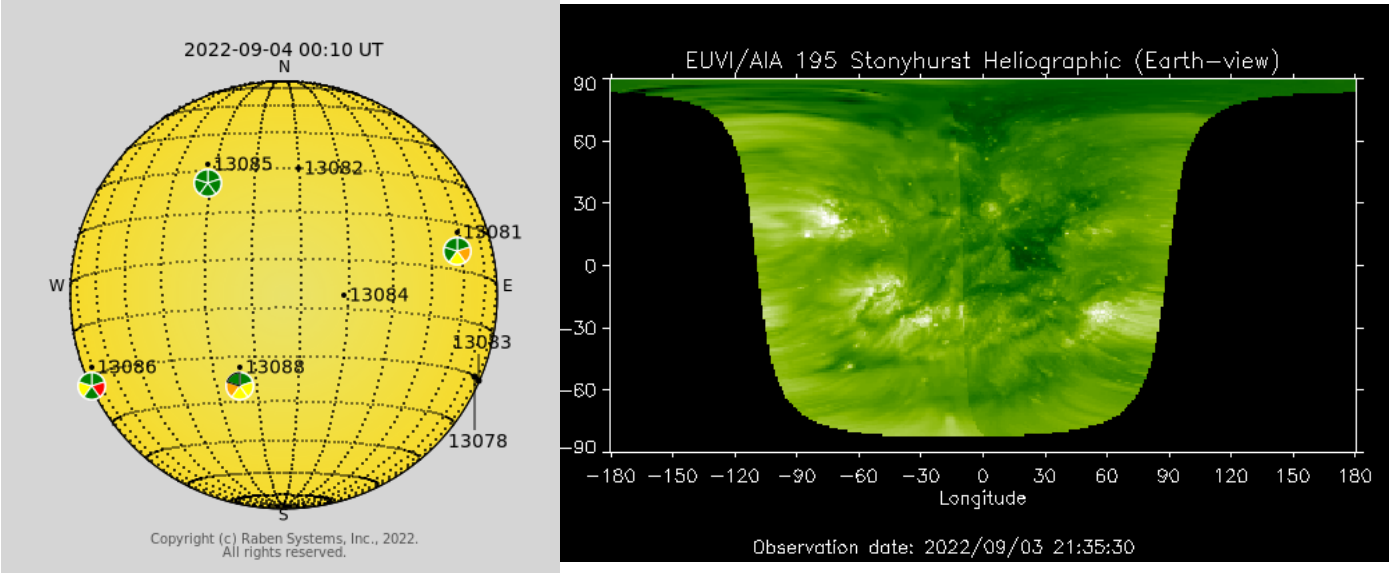
EUVI/AIA 195 imagery but may rotate onto the northeast limb at the end of day 2 (05th), potentially increasing the probabilities of significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	35	35	35
Very Active	R3 to R5 X Class	No	3	3	3	3

Figure 4: Farside map from Raben Sysems, Inc (left) and latest EUVI/AIA 195 imagery (right)



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) remains at background values. Despite and apparent stability, AR3089 (Eki/Beta-Gamma-Delta) continues to present a slight chance of a proton event at Earth, should there be any significant flaring. This risk will continue as the region rotates further across the southwestern quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	3	3	3	3
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux has become moderate, due to the recent enhancement from the fast speed stream originating from CH19/+, recharging the Van Allen belts in electron populations. A more notable enhancement is expected once the high speed stream from CH20/+ connects with Earth, leading to a more significant increase within the next 24 hours. The electron flux is expected to reach high levels, however any geomagnetic activity (following the onset of the HSS or due to CME influences) will temporarily suppress the electron counts, inevitably generating some uncertainty with regards to the timing. Flux levels are then expected to rise erratically during day 1 and day 2, before comfortably remaining above high levels during day 3 and day 4.

The corresponding 24-hour fluence is expected to display a sharp rising trend from 04 Sept (day 1) onward, with a chance of exceeding the Active threshold from day 3 (06th) onwards. This is supported the latest Met Office REFM output, although the model is considered to slightly under-estimate the fluence levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	30	50	70
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	5

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Figure 5: GOES-16 Electron Flux from previous rotation

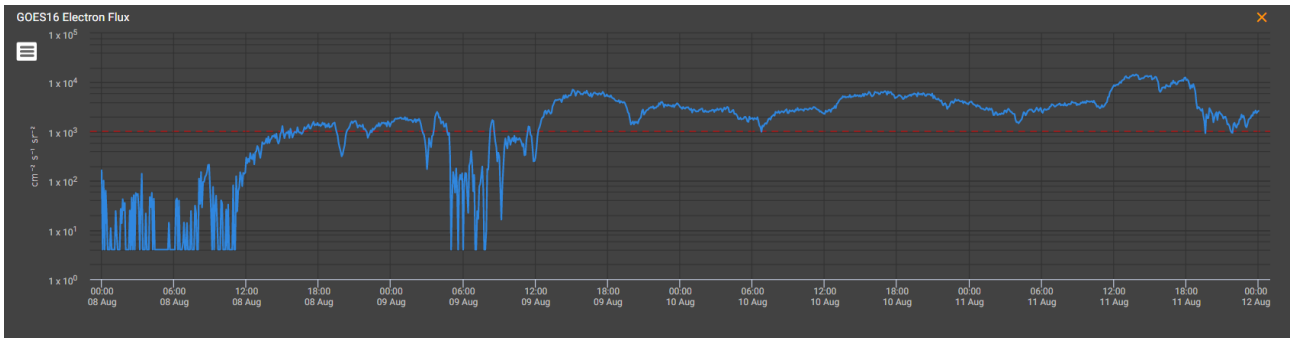
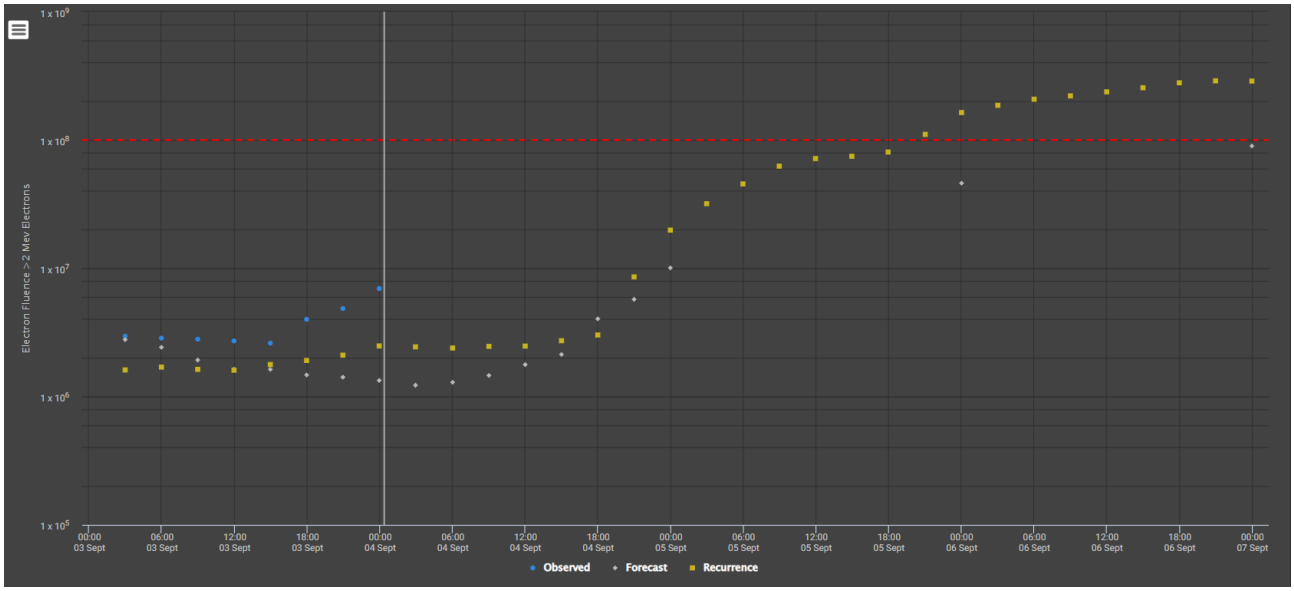


Figure 6: Latest REFM output, considered to provide reasonable guidance



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